DEC STD 080-2 Digital Product Safety Industrial Control Equipment - Test Methods

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ABSTRACT: Presents general information about test procedures required to determine that products meet design criteria of DEC STD 080-1 and lists the detailed test methods which define the procedures to perform a specific test.

APPLICABILITY: This standard applies to all industrial control equipment sold by Digital. Some product areas, such as software, furnishings, or other market areas, may not have applicable requirements within this document. However, general principles of safety still apply. The requirements of this standard apply to all products in Phase 0 or Phase 1 on the date this standard is approved. See DEC STD 080-0, subhead 2.1.1, Product Safety Standards Policy.

STATUS: APPROVED 15-Feb-1991; use VTX SMC for current status.

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1 DEVICE PERFORMANCE

a. The performance of INDUSTRIAL CONTROL EQUIPMENT shall be investigated by subjecting a representative sample or samples in commercial form to the tests described in this standard. Those tests that are required to be conducted in a sequence are indicated in Table 1.

b. Temperature or current sensitive devices or systems that cause termination of a test shall be additionally evaluated to determine their suitability for the application.

c. Unless otherwise indicated, the tests are to be conducted at RATED FREQUENCY at the applicable voltage specified in Table 2.

   Exception: EQUIPMENT designed for operation at more than one frequency shall be tested at the frequency that will produce the highest temperature rise.

d. Unless indicated otherwise, the tests are to be conducted at any ambient temperature within the range of 10 - 40°C (50 - 104 °F). The ambient temperature is to be determined using either thermometers or thermocouples placed in the vicinity of the EQUIPMENT being tested.

e. INDUSTRIAL CONTROL EQUIPMENT with an incomplete or partial ENCLOSURE is considered to be OPEN EQUIPMENT with respect to the performance requirements in this standard.

f. OPEN EQUIPMENT shall be mounted in an ENCLOSURE considered representative of the intended use. The maximum ENCLOSURE dimensions are to be determined by one of the following methods:

   1. 150 % of the dimensions of the device - that is, length, width, and height.
   2. Dimensions needed to meet the wire-bending space specified in Table 12.
   3. Dimensions of the intended ENCLOSURE, such as a standard outlet box.
   4. The intended ENCLOSURE, which may be larger than indicated in items (1) through (3) provided the size is marked on the device or a separate stuffer sheet.

g. A reversing controller, a selector switch, a meter switch, 2-circuit or 3-circuit EQUIPMENT, or other type of device in which there are two or more on and off positions is to be connected for tests so that opposite polarity representative of normal use exists between or across open contacts or parts.

   Exception: EQUIPMENT on which same polarity is indicated by MARKING is to be connected as indicated in the MARKING.

Table 1: Sequence of Tests

		Sample Number (a)	
		1	2
Subhead	Test	Sequence	Sequence
2.2	Temperature	1	
2.15	Overvoltage and Undervoltage	2	
2.12	Overload		1
2.13	Endurance		2
2.3	Dielectric Voltage Withstand	3	3

(a) All or any combination of sequences may be conducted on a single sample if agreeable to those concerned. One sequence need not be completed as a prerequisite to the starting of another.

2 TEMPERATURE TEST

a. INDUSTRIAL CONTROL EQUIPMENT tested under the conditions described in (b) through (g) shall not attain a temperature at any point sufficiently high to constitute a risk of fire or to adversely affect any materials employed in the EQUIPMENT, nor show temperature rises above test room ambient at specific points greater than those specified in Table 3.

   Exception: Table 3 does not apply to a contact element that is mounted directly to a resistor element or to a brush on a variable-voltage autotransformer.

b. The temperature rises specified in Table 3 are based on an ambient temperature of 25°C and apply to EQUIPMENT intended for use in ambient temperatures normally prevailing in occupiable spaces. The ambient temperatures in occupiable spaces usually are not higher than 25 °C but may be as high as 40°C occasionally and for brief periods. Tests of EQUIPMENT for service with such ambient temperatures may be conducted (without correction) at any ambient temperature between 10 and 40°C. If EQUIPMENT is rated specifically for use in a prevailing ambient temperature constantly more than 25°C, the test of the EQUIPMENT shall be made with that higher ambient temperature, and the allowable temperature rises shall be reduced by the amount by which the higher ambient exceeds 25°C.

   Temperatures shall be determined by thermocouples, or the rise-of-resistance method; except that, in special cases, one method may be specified by the testing authority. A temperature shall be considered to be constant when 3 successive readings taken at 5 minute intervals indicate no change. If thermocouples are used for measuring coil temperatures, temperature rises 10 °C higher than those specified (by thermocouple) in Table 3 may be recognized, provided that the temperature rise as determined by the rise-of-resistance method is within the prescribed limits.

c. The temperature on the back of EQUIPMENT shall not exceed 50°C (90 °F) rise above a room temperature of 40°C (104 °F) when operated under normal conditions, or the construction shall be such that only the points of support will be in contact with a

plane mounting surface with the remainder of the EQUIPMENT spaced at least 1/4 inch (6.4 mm) from the mounting surface.

d. To determine whether INDUSTRIAL CONTROL EQUIPMENT complies with the temperature test requirements, it is to be operated under normal conditions and is to carry its RATED CURRENT continuously until constant temperatures are attained. The frequency and voltage shall be as specified in subhead 2.1 Device Performance, item (c). An overload relay shall not trip during the test.

   Exception: Instead of the voltages specified, a low voltage source of supply may be used for temperature tests on parts other than voltage rated coils.

e. Temperatures are to be measured with all parts operating simultaneously that is possible within the normal operation of the EQUIPMENT, as the heating of one part may affect the heating of another part.

f. For EQUIPMENT having a current-element table showing minimum and maximum full-load motor currents, the temperature test shall be conducted using the maximum full-load current shown in the table even though that current exceeds the maximum current rating of the EQUIPMENT. For EQUIPMENT having a current-element table showing only tripping current, the test current is to be 87 % of the specified maximum tripping current.

g. For an auxiliary switch mounted directly to a contactor or starter, the test current is to correspond to the maximum break current consistent with the switch rating.

h. INDUSTRIAL CONTROL EQUIPMENT is to be tested with 4 feet (1.2 m) of wire attached to each FIELD-WIRING TERMINAL. The wire is to be of the smallest size having an ampacity of at least 125 % of the test current for motor loads and at least 100 % for other loads. The wire size is to be in accordance with Table 4 based on the wire temperature rating marked on the EQUIPMENT. The type of insulation is not specified. The temperature test may be conducted with conductors having other than black insulation, but referree temperature measurements are to be conducted with black-insulated conductors. If the terminal will not receive the size of wire required for testing in accordance with item (f) for EQUIPMENT having an overload relay, or if the device is marked in accordance with subhead 1.22.1 Permanently Connected Equipment, item (e) to limit the size of wire, the maximum allowable wire size is to be used.

   Exception: If there is only provision for the connection of bus bars to INDUSTRIAL CONTROL EQUIPMENT rated at 450 amperes or more, copper bus bars 1/4 inch (6.4 mm) thick of the width specified in Table 5 and at least 4 feet (1.2 m) in length are to be used. The temperature test may be conducted with other than black-painted bus bars, but if referee temperature measurements are required, black-painted bus bars are to be used. The spacing between multiple bus bars is to be 1/4 inch (6.4 mm) with no intentional wider spacing except as necessary at the individual terminals of the EQUIPMENT.

i. If referee measurements of ambient temperatures are necessary, several thermometers are to be placed at different points around the EQUIPMENT at a distance of 3 to 6 feet (0.9 to 1.8 m). The thermometers are to be located in the path of the cooling medium, but are to be protected from drafts and abnormal heat radiation. The ambient temperature is to be the mean of the readings of the temperatures taken at equal intervals of time during the final quarter of the duration of the test.

j. The acceptability of insulating materials other than those specified in Table 3 is to be determined with respect to properties such as flammability, arc-resistance, and the like, based on an operating temperature equal to the measured temperature rise plus 40°C (72 °F).

k. For a device employing a fuseholder, an unplated copper bar, unplated copper tubing, or an equivalent material with negligible impedance is to be used during the test instead of a regular fuse.

Exception: A product such as a combination motor controller intended to be used with Class L fuses is to be tested with the fuse installed as intended in service. The fuse is to have the maximum ampere rating specified by the manufacturer's current-element tables. The device is to operate normally until constant temperatures are obtained at 100 % RATED CURRENT without (1) the opening of any fuse, and (2) without the temperature rise exceeding that specified in Table 3.

l. The thermocouple method for temperature measurement as specified in Table 3 consists of the determination of temperature by use of a potentiometer type instrument and thermocouples that are applied to the hottest accessible parts. The thermocouples are to be made of wires not larger than No. 24 AWG and not smaller than No. 30 AWG. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements for special thermocouples as listed in the table of limits of error of thermocouples in Temperature Measurement Thermocouples, ANSI MC96.1-1975.

m. A thermocouple junction and adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will result from securely taping or cementing the thermocouple in place; but if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

n. The resistance method for temperature measurement as specified in Table 3 consists of the calculation of the temperature rise of a winding using the equation:

$$\Delta T = r_2/r_1 * (k + t_1) - (k + t_2)$$

in which:

ΔT is the temperature rise of the winding in degrees C.
r_2 is the resistance of the coil at the end of the test in ohms.
r_1 is the resistance of the coil at the beginning of the test in ohms.
t_1 is the room temperature in°C at the beginning of the test.
t_2 is the room temperature in°C at the end of the test.
k is 234.5 for copper; values of the constant for other conductors are to be determined.

o. Because it is generally necessary to de-energize the winding before measuring r_2, the needed value of r_2 at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time may be plotted and extrapolated to give the value of r_2 at shutdown.

p. The preferred method of measuring the temperature of a coil is the resistance method; but temperature measurements by either the thermocouple or resistance method are acceptable; except that the thermocouple method is not to be employed at any point where supplementary insulation is employed.

Table 2: Values of Voltage for Tests

	Voltage Rating of Equipment (a)				
Test	100 - 120	208 - 240	254 - 277	440 - 480	560 - 600
Temperature	120	240	277	480	600
Overvoltage, ac or dc	132	264	305	528	660
Undervoltage, ac	102	204	235	408	510
Undervoltage, dc	96	192	222	384	480
Overload	120	240	277	480	600
Endurance	120	240	277	480	600

(a) If the rating of the equipment does not fall within any of the indicated voltage ranges, it is to be tested at its rated voltage except for the overvoltage and undervoltage test.

Table 3: Maximum Allowable Temperature Rises

Item	Material and Component Parts	°C
1.	Relays and solenoids	
	Coils with Class A insulation	
	By thermocouple	65
	By resistance	85
	Coils with Class B insulation	
	By thermocouple	85
	By resistance	105
2.	Power transformers and reactors	
	Windings with Class A insulation	
	By resistance	70
	Windings with Class B insulation	
	By resistance	95
3.	Enclosure	65
4.	Class 2 Transformer Enclosure	60
5.	At any point on or within a supply terminal box or on the supply conductors	35 (a)
6.	On surfaces adjacent to or upon which a unit may be mounted in service	65
7.	Insulated conductors	Rated temp. -25
8.	Contacts, busses, connecting bars	100 (b)
	All other metals	65
9.	Field wiring terminals	50
10.	Fuses	65
11	Fuse clips	30
12.	Fiber employed as electrical insulation	65
13.	Varnished cloth insulation	60
14.	Phenolic composition employed as electrical insulation or as a part whose failure would result in a hazardous condition	125 (c)
15.	Sealing compounds	Melting point - 40
16.	Capacitors	
	Electrolytic type	40 (d)
	Other types	30 (e)

a. Temperatures not exceeding the temperature rating of the supply wires are permitted, provided that equipment is marked in accordance with DEC STD 178-3.
b. The maximum acceptable tempature rises for copper construction are determined by the temperature limitations on the bus supports, material for adjacent parts, or 100°C (212 °F) temperature rise on the bus, whichever is lower. There is to be no structural deterioration of the assembly, loosening of parts, cracking or flaking of material, loss of temper of spring, annealing of parts, or other visible damage.
c. This limitation does not apply to a compound that has been investigated and recognized as having suitable heat resitant properties.
d. Higher temperatures may be accepted subject to investigation.
e. The maximum acceptable temperature rise is the marked temperature limit of the capacitor minus an assumed ambient temperature of 25°C (77 °F).
f. The maximum acceptable temperature rise on the case is the maximum case temperature for the applied power dissipation recommended by the semiconductor manufacturer minus an assumed ambient of 40°C (104 °F) for an enclosed device and 50°C (122 °F) for an open device.
g. The maximum acceptable operating temperature of the printed-wiring board shall not be exceeded.

Table 3 (Cont.): Maximum Allowable Temperature Rises

Item	Material and Component Parts	°C
17.	Rubber or thermoplastic installed conductors	35
18.	In the issuing air, 1 inch (25.4 mm) above the enclosure	175
19.	Insulation systems	
	Class 105 insulation systems	
	Thermocouple method	65
	Resistance method	85
	Class 105 insulation systems on single-layer series coil with exposed surfaces either uninsulated or enameled, thermocouple method	90
	Class 130 insulation systems	
	Thermocouple method	85
	Resistance method	105
20.	On the embedding material of a resistor, a rheostat, and a wall mounted dimmer with an embedded resistive element	300
21.	On the embedding material of a rhostatic dimmer having embedded resistive conductors, and arranged for mounting on a switchboard, or in a noncombustible frame	350
22.	On bare resistor material, themocouple method	375
23.	Power swithching semiconductors	(f)
24.	Printer-wiring boards	(g)

Table 4: Ampacities of Insulated Copper Conductors (a),(b)

Wire Size		RATING	
		60 °C (140 °F)	75 °C (167 °F)
AWG	mm^2		
14	2.1	15	15
12	3.3	20	20
10	5.3	30	30
8	8.4	40	50
6	13.3	55	65
4	21.2	70	85
3	26.7	85	100
2	33.6	95	115
1	42.4	110	130
1/0	53.5		150
2/0	67.4		175
3/0	85.0		200
4/0	107.2		230
MCM			
250	127		255
300	152		285
350	177		310
400	203		335
500	253		380
600	304		420
700	355		460
800	405		490
900	456		520
1000	506		545
1250	633		590
1500	760		625
1750	887		650
2000	1013		665

a. For multiple-conductors of the same size (1/0 AWG or larger) at a terminal, the ampacity is equal to the value for that conductor multiplied by the number of conductors that the terminal will accommodate.

b. These values of ampacity apply only if not more than three conductors will be field-installed in the conduit. If four or more conductors, including a neutral that carries the unbalanced current excluding safety earth ground conductor, will be installed in a conduit (as may occur because of the number of conduit hubs provided in an outdoor equipment, the number of wires necessary in certain polyphase systems, or other reasons) the ampacity of each of the conductors is: 80 % of these values if 4 - 6 conductors are involved, 70 % of these values if 7 - 24 conductors, 60 % of these values if 25 - 42 conductors, and 50 percent of these values if 43 or more conductors.

Table 5: Width of Copper Bus Bars

Product Rating, Amperes	Bus Bars per Terminal	Width of Bus Bars, Inches (mm)
450 - 600	1	2 (51)
601 - 1000	1	3 (76)
1001 - 1200	1	4 (102)
1201 - 1600	2	3 (76)
1601 - 2000	2	4 (102)
2001 - 2500	2	5 (127)
	4	2½ (64)
2501 - 3000	3	5 (127)
	4	4 (102)

3 DIELECTRIC VOLTAGE-WITHSTAND TEST

3.1 UL REQUIREMENTS

The dielectric voltage withstand test is to be conducted immediately after the temperature test with the sample at stabilized temperature and, where necessary, having the power semiconductor (in power circuit) shorted. If placement of thermocouples could adversely affect the results of the dielectric voltage withstand test, the test may be conducted on a sample without thermocouples that has been operated as defined for the temperature test until temperatures have stabilized.

a. INDUSTRIAL CONTROL EQUIPMENT shall withstand the application of a 60 hertz sinusoidal potential of 1000 volts plus twice maximum RATED VOLTAGE for 1 minute without breakdown:

   1. Between uninsulated LIVE PARTS and the ENCLOSURE with the contacts open and closed,
   2. Between terminals of opposite polarity with the contacts closed, and
   3. Between uninsulated LIVE PARTS of different circuits.

b. A transformer, a coil, an electronic part, or a similar device normally connected between lines of opposite polarity is to be disconnected from one side of the line during the test described in item (a) (2).

c. If a barrier or liner is employed to insulate an exposed metal part, the EQUIPMENT shall withstand a dielectric voltage-withstand test, as described in item (a), between current-carrying parts and the exposed noncurrent-carrying metal parts.

d. If the EQUIPMENT has a meter or meters, they are to be disconnected from the circuit for the dielectric voltage-withstand test described in items (a) through (c). The meter or meters are to be tested separately for dielectric voltage withstand, with an applied potential of 1000 volts in the case of an ammeter, and 1000 volts plus twice RATED VOLTAGE in the case of any instrument having a potential circuit.

e. To determine whether INDUSTRIAL CONTROL EQUIPMENT complies with the requirements in items (a), (c), and (d), it is to be tested by means of a 500 volt-ampere or larger capacity transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero to the required

value at a substantially uniform rate and as rapidly as is consistent with its value being correctly indicated by a voltmeter.

Exception: A 500 volt-ampere or larger capacity transformer need not be used if the transformer is provided with a voltmeter that directly measures the applied output potential.

f. There shall be no breakdown of a coil assembly during the procedures described in items (g) through (j).

g. Three separate samples of the assembly of coil and frame shall be subjected to this test after constant temperatures have been reached as the result of operation under the conditions specified under subhead 2.2 item (c) through item (h). While heated from the normal temperature test, the coil terminals are to be connected to an alternating current source of twice the normal RATED VOLTAGE at any frequency up to 400 hertz.

h. The required test voltage specified in item (g) is to be obtained by starting at one-quarter or less of the full rated value and increasing to twice full rated value in not more than 15 seconds. After being held for 7200 electrical cycles or for 60 seconds, whichever is less, the voltage is to be reduced within 5 seconds to one-quarter or less of the maximum rated value and the circuit is to be opened.

i. While heated following operation at 110 % of its rated voltage, each of the three samples are to be subjected to the test described in items (g) and (h), except that the test voltage is to be 130 % of the temperature test voltage.

j. If the temperature that a coil winding reaches in the tests described in items (g) and (i), is known, an oven that can be set at the required temperature may be used to condition the sample to that temperature before conducting the test.

3.2 CSA REQUIREMENTS

While at normal operating temperature, the EQUIPMENT shall withstand for one minute without breakdown the application of the following ac voltages:

a. 1000 V for EQUIPMENT rated 250 V or less, and 1000 V plus twice RATED VOLTAGE for EQUIPMENT rated at more than 250 V between low voltage LIVE PARTS and the ENCLOSURE if such circuits leave or enter the enclosure;

b. 1000 V for EQUIPMENT rated 250 V or less, and 1000 V plus twice RATED VOLTAGE for EQUIPMENT rated at more than 250 V between LIVE PARTS of low and FELV circuits and different low voltage circuits if such circuits leave or enter the ENCLOSURE; and

c. 500 V between FELV LIVE PARTS and the ENCLOSURE if such circuits leave or enter the ENCLOSURE.

Capacitors in the secondary circuit shall be disconnected during the dielectric strength tests specified in items (a) to (c).

The test specified in item (c) shall be waived on grounded or Class 2 circuits.

Where it can be shown that a component such as a noise suppressor cannot be a source of shock or fire hazard, it may be disconnected during this test.

A transformer, if provided, shall withstand for one minute without breakdown the application of an ac voltage of 1000 V plus twice the maximum voltage of the winding applied between each winding and all other windings, the core, and the ENCLOSURE; except that, if the maximum low voltage does not exceed 30 V, the test voltage may be reduced to 500 V. Ungrounded metallic shields are to be treated as windings when performing this test.

Where it is more convenient to do so, the dielectric strength test may be made by applying a dc voltage instead of an ac voltage, provided that the voltage used is 1.414 times the values specified.

Where required by subhead 1.31 Spacings, item (h)(2)(c), the following test voltage shall be applied for one minute between circuits of opposite polarity and between the circuits and the enclosure. Components that would be damaged or that would cause excessive test current, such as transistors, may be removed from the circuit.

Maximum Circuit Voltage, rms	Test Voltage, rms
30 V and less	No test
Over 30 V, up to 250 V	1000 V
Over 250 V	1000 V + twice the circuit voltage

3.3 IEC REQUIREMENTS

The electrical EQUIPMENT shall be subjected, for a duration of one minute, to a voltage test, by applying a test voltage as defined below:

a. Between the short-circuited conductors of the power circuits, including any control and signaling circuits connected to the power circuits and the protective circuit, which includes the frame, and

b. If applicable, between control and signaling circuits with nominal voltages of 50 V and higher, which are not connected to power circuits, and the protective circuit.

The test voltage shall be equal to 85% of the lowest test voltage to which all components and devices will have already been tested before assembly, with a minimum of 1500 V ac.

This voltage shall be supplied from a transformer with a rating of at least 500 VA.

For very large electrical EQUIPMENT individual tests on each section are permitted.

Components and devices which are not designed to withstand such a high test voltage (rectifiers, capacitors, electronic apparatus, and so forth) may be disconnected during the test. Nevertheless, radio interference capacitors fitted between LIVE PARTS and exposed conductive parts shall not be disconnected and must withstand this test.

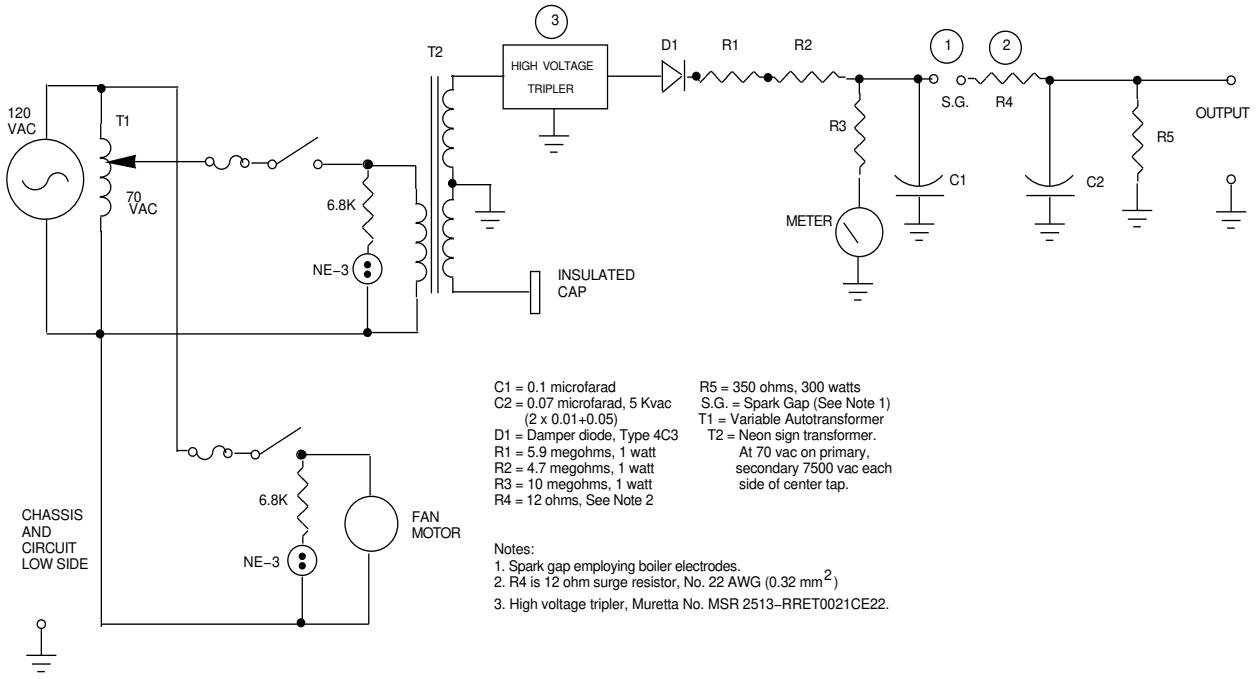
4 TRANSIENT VOLTAGE-SURGE SUPPRESSION TEST

a. A surge-controlled circuit as specified under subhead 1.31 Spacings, items (a) and (b) shall withstand without breakdown a single 1.2 by 50 microseconds full-wave impulse with a crest value of 5.0 kilovolts. See Standard Techniques for Dielectric Tests, ANSI C68.1-1968. The transient voltage surge shall not exceed 300 % of the peak working voltage, or 300 volts, whichever is greater and the EQUIPMENT shall be operative after conclusion of the test.

b. The wave form mentioned in item (a) may typically be provided by an impulse generator illustrated in Section 4 when operated under open-circuit conditions. Caution should be exercised to prevent back surges on the line.

c. The EQUIPMENT is to be connected to a single-phase source of supply operating at RATED VOLTAGE with the impulse generator connected across the EQUIPMENT.

Figure 1: Typical Impulse Generator



5 ACCELERATED AGING TESTS

a. When tested as described in item (b), a sealing compound shall not melt, become brittle, or otherwise deteriorate to a degree that will affect its sealing properties as determined by comparing the conditioned sample to an unconditioned sample.

b. A sealing compound is to be applied to the surface it is intended to seal. For a temperature rise not exceeding 35°C (63 °F), a representative sample of the surface with the sealing compound applied is to be conditioned for 7 days in an air oven at 87°C (189 °F).

6 BREAKDOWN OF COMPONENTS TEST

There shall be no emission of flame or molten metal nor ignition of cotton loosely placed over all openings of ventilated EQUIPMENT or totally around open devices when capacitor, diodes, or other solid state COMPONENTS are short- or open-circuited.

Exceptions: The test is not required:

a. If circuit analysis indicates that no other COMPONENT or portion of the circuit will be seriously overloaded as a result of the assumed open circuiting or short circuiting of another COMPONENT.

b. For COMPONENTS in Class 2 circuits.

c. For COMPONENTS in limited energy secondary circuits as defined in DEC STD 080-1 under subhead 1.25 Isolated Power Supply, items (a) through (h).

d. On power semiconductor devices if equivalent testing is accomplished during short circuit tests.

e. For COMPONENTS complying with requirements applicable to the COMPONENT.

7 WIRE FLEXING TEST

The wiring to COMPONENTS mounted on a door is to be tested by opening the door as far as possible - restraints such as a chain are to remain in place - and then closing it for 500 cycles of operation. Following this test, the EQUIPMENT is to be subjected to a dielectric voltage withstand test, described in subhead 2.3, applied between conductors and between conductors and ground at 1000 volts ac plus twice maximum RATED VOLTAGE.

8 TERMINAL TORQUE TEST

a. The insulating damaged when a condu the clamping screw is torqued to 110 percent of the value marked on the EQUIPMENT.

b. To determine that an insulating base complies with the requirement in item (a), the EQUIPMENT is to be mounted as intended and may be fitted with a short length of rigid CONDUIT. A short length of field-wiring conductor of rated ampacity is to be routed through the CONDUIT, if fitted, and connected to the terminal. The wiring terminal clamping screw is then to be tightened to 110 % of the value of torque specified on the equipment. For equipment marked for use with copper conductors, the wire connectors are to be torqued to 110 % of the highest torque value marked for the conductor.

c. Damage is considered to have occurred if the base insulating material breaks or cracks; bosses, recesses, or other means to prevent turning do not perform their intended function; straps or bus bars bend or twist; or members move at electrical joints if such movement would reduce spacings to an unacceptable degree or otherwise impair the electrical connection. Minor chipping or flaking of brittle insulating material or momentary flexing of metallic members without permanent deformation is acceptable.

9 IMPACT TESTS

9.1 OBSERVATION OPENINGS

a. The test shall be made as specified under subhead 2.9.3 Test Procedure. For materials that are relied upon for protection against shock, fire, or mechanical hazards, the impact shall be 7 ± 0.2 J. For other materials, the impact shall be 0.5 J.

b. A single impact shall be applied at right angles to the surfaces with the EQUIPMENT in its normal position.

c. The material shall not fracture.

9.2 NONMETALLIC ENCLOSURES

a. The test shall be made as under subhead 2.9.3 Test Procedure with an impact of 7 ± 0.2 J.

b. A single impact shall be applied to the top, sides, front, and rear, with the EQUIPMENT in its normal position.

c. There shall be no openings that do not comply with heading 1.11 Accessibility, and there shall be no other damage that results in the reduction of electrical spacings below the minimum specified under heading 1.31 Spacings.

9.3 TEST PROCEDURE

a. The impact shall be applied by a solid, smooth, steel sphere 50 ± 1 mm in diameter, weighing approximately 0.53 kg (1.17 lbs).

b. For top surfaces, the steel sphere shall be allowed to fall freely from rest through the distance required to cause it to strike the ENCLOSURE so that the sphere has the specified energy.

c. For surfaces other than the top, the steel sphere shall be suspended by a fine wire and allowed to fall as a pendulum through the distance required to cause it to strike the surface with the specified impact, and the ENCLOSURE shall be placed so that the surface to be tested is vertical and in the same vertical plane as the point of support of the pendulum.

10 LEAKAGE CURRENT TESTS

a. The measurements given under items (c) and (d) below shall be made while the EQUIPMENT is at operating temperature. These measurements are not required for EQUIPMENT energized from a source less than 30 V rms or 42 volts dc.

b. The impedance of the measuring circuit shall be 1500 ohms shunted by a 0.15 µF capacitor.

c. With the EQUIPMENT energized at the nominal voltage and frequency

   1. The leakage current that flows in the grounding conductor, with the EQUIPMENT mounted on an ungrounded surface, shall not exceed 3.5 mA, except that, for EQUIPMENT requiring grounding for the elimination of signal interference, the leakage current may be greater than 3.5 mA, provided that the user is warned

that a ground connection is to be made before power is applied in accordance with labeling requirements under DEC STD 178-3, subhead 11.1 High Leakage Current.

2. The leakage current that flows between any ungrounded signal or CONTROL CIRCUITS that enter or leave the ENCLOSURE and the grounding conductor shall not exceed 0.5 mA.

d. For multi-channel EQUIPMENT, with a rated circuit-to-ground voltage exceeding 30 V and 3.5 mA source current, the following test shall be performed. The measuring terminals of all but one channel shall be shorted together and energized with the rated circuit-to-ground voltage. The current that flows between the remaining channel and the ENCLOSURE or between the bare LIVE PARTS that are accessible during operational maintenance and the grounding conductor shall not exceed 0.5 mA.

11 OVERLOAD TEST OF CONTROL DEVICES

As an alternative to the overload test, a switch or relay used to control an internal fixed load may be tested by making and breaking, for 50 cycles of operation at the rate of 6 cycles per minute, the load that it is intended to control with the EQUIPMENT operating at 110% of the nominal supply voltage.

12 ENDURANCE TEST OF CONTROL DEVICES

As an alternative to the endurance test, a switch or relay used to control an internal fixed load may be tested by making and breaking, for 6000 cycles of operation at the rate of 6 cycles per minute, the load that it is intended to control at the nominal voltage.

13 ENCLOSURE TESTS

The performance requirements of an ENCLOSURE are determined by the specific environmental type designation and other features such as gasketing or use of materials thinner than required by Tables 1 or 2 of this standard.

An ENCLOSURE shall be subjected to the tests specified in Table 4, applicable to an ENCLOSURE of the type number or numbers with which it is marked.

An external operating means - such as those for a disconnect, a pilot device, or a resetting operation - mounted on or through an ENCLOSURE shall withstand the tests specified for the ENCLOSURE unless otherwise indicated.

The results of the tests are specified for UL ENCLOSURE type numbers. See Table 4 for the applicable CSA or IEC designations.

13.1 AIR PRESSURE TEST

The ENCLOSURE is to be fitted with CONDUIT, pressure gauge, and check valve. The CONDUIT is to be connected with pipe thread sealing compound and is to be tightened to the torque value specified under subhead 2.13.10. The internal pressure of the ENCLOSURE is then to be raised to 6 psig (41.3 kPa) and the check valve is to be closed. The pressure is to be read 24 hours later.

If a UL Type 6P ENCLOSURE does not have connections for pressurizing the interior, the ENCLOSURE shall comply with the Submersion Test except that the duration of the submersion is to be 24 hours.

At the conclusion of the procedure, a UL Type 6P ENCLOSURE shall have a minimum internal pressure of 4 psig (27.6 kPa).

13.2 ATOMIZED WATER TEST

The Atomized Water Test is an alternate to the Dust Test. See subhead 2.13.5.

The ENCLOSURE is to be subjected to a spray of atomized water by using a nozzle that produces a round pattern 3 - 4 inches (75 - 100 mm) in diameter measured 12 inches (305 mm) from the nozzle. The pressure is to be 30 psi (207 kPa). The water is to be supplied by a suction feed with a siphon height of 4 - 8 inches (100 - 205 mm). No less than 5 fluid ounces per linear foot (485 cc/m) of test length - the sum of the height plus the width plus the depth of the test specimen - is to be applied at a rate of 3 gallons (11.4 L) per hour. The nozzle is to be held 12 - 15 inches (305 - 380 mm) from the ENCLOSURE, and the spray of water is to be directed at all areas of potential dust entry, such as seams, joints, and external operating mechanisms. A CONDUIT may be installed to equalize the internal and external pressures, but it is not to serve as a drain. No sealing compound other than that which is normally provided by the manufacturer is to be used.

At the conclusion of the procedure an ENCLOSURE shall have no water inside.

13.3 CORROSION RESISTANCE TEST

The ENCLOSURE is to be subjected to the test described under subhead 2.13.11 Rust Resistance Test, except that the exposure time is to be 200 hours.

At the conclusion of the procedure a UL Type 11 ENCLOSURE shall not show pitting, cracking, or other deterioration more severe than that resulting from a similar test on passivated American Iron and Steel Institute Type 304 stainless steel.

13.4 DRIP TEST

The ENCLOSURE is to be mounted beneath a drip pan that produces both splashing and dripping and extends beyond all exposed sides of the ENCLOSURE. The bottom of the drip pan is to be equipped with uniformly distributed spouts; one spout for each 20 square inches (129 cm^2) of pan area. Each spout is to drip water at a rate of approximately 20 drops per minute. The ENCLOSURE is to be subjected to continuously dripping water for 30 minutes.

At the conclusion of the procedure:

a. A UL Type 2 or UL Type 11 ENCLOSURE shall have:

   1. No water visible on insulation, any electrical COMPONENT, or mechanism of the assembly; and
   2. No significant accumulation of water retained by the assembly so that the likelihood of corrosion is reduced.

b. A UL Type 12 ENCLOSURE shall have no water inside.

13.5 DUST TEST

The ENCLOSURE is to be subjected to a blast of compressed air mixed with dry cement as specified below by means of a suction-type sandblast gun equipped with a 3/16 inch (4.7 mm) diameter air jet and a 3/8 inch (9.5 mm) diameter nozzle. The air is to be at a pressure of 90 - 100 psig (620 - 690 kPa). The cement is to be supplied by a suction feed. At least 4 pounds of cement per linear foot (5.9 kg/m) of test length - the sum of the height plus the width plus the depth of the test specimen - is to be applied at a rate of 5 pounds (2.27 kg) per minute. The nozzle is to be held 12 - 15 inches (305 - 380 mm) from the ENCLOSURE, and the blast of air and cement is to be directed at all areas of potential dust entry, such as seams, joints, and external operating mechanisms. A CONDUIT may be installed to equalize the internal and external pressure.

Type 1 general purpose portland cement is to be used as it has a controlled particle size distribution. The analysis of a typical sample is as indicated in Table 6.

At the conclusion of the procedure a UL Type 3, 3S, or 12 ENCLOSURE shall have no dust inside.

Exception: Such ENCLOSURES are considered to comply with this requirement if they comply with the requirements for the Atomized Water Test, subhead 2.13.2, or the Hosedown Test, subhead 2.13.6.

In addition, a CSA ENCLOSURE 5 containing electrical EQUIPMENT shall be subjected to a temperature (blanketing) test described in CSA Standard C22.2 No. 25.

Table 6: Particle Size of Cement

	Particle Size		
Mesh	Inch	mm	Percent Content
Coarser than 200	Larger than 0.0029	0.074	3
200	0.0029	0.074	8
325	0.0017	0.043	7
400	0.0015 or smaller	0.038	82

13.6 HOSEDOWN TEST

A CONDUIT may be installed on the ENCLOSURE to equalize internal and external pressures, but it is not to serve as a drain. No sealing compound other than that normally provided by the manufacturer is to be used. The ENCLOSURE interior is to be dry.

The ENCLOSURE and its external mechanisms are then to be sprayed by water from a hose having a 1 inch (25.4 mm) inside diameter nozzle that delivers at least 65 gallons (246 L) of water per minute. The water stream is to be directed at the joints of the ENCLOSURE from a distance of 10 - 12 feet (3.0 - 3.7 m) and is to be moved along the joints or surface at a minimum rate of 4 seconds per linear inch (25 mm).

For an ENCLOSURE having a test length - height plus width plus depth dimension - of 75 inches (1.91 m) or less, the duration of the water stream contact with the ENCLOSURE is to be 5 minutes. For an ENCLOSURE having a test length exceeding 75 inches (1.91 m), the duration of water stream contact in minutes is to be the test length measured in inches divided by 15 (2.62 times the test length measured in meters).

At the conclusion of the procedure, a UL Type 4 or Type 4X ENCLOSURE shall have no water inside.

13.7 ICING TEST

NOTE

If such an ENCLOSURE has no external cavities that trap water, the ENCLOSURE is considered to comply without conducting this test.

The ENCLOSURE is to be mounted in a room that can be cooled to 20 °F (minus 6.7°C). A metal rod 1 inch (25.4 mm) in diameter and 2 feet (610 mm) long is to be mounted in a horizontal position in a location where it will receive the same water spray as the ENCLOSURE being tested. Provision is to be made for spraying the entire ENCLOSURE from above with water at an angle of approximately 45 degrees from the vertical. The water is to be 32 - 37 °F (0 - 2.8°C). Spraying facilities that provide 1 - 2 gallons per hour per square foot (0.352 - 0.703 L/hr/m^2) of area to be sprayed are acceptable. The room temperature is to be lowered to 35 °F (1.7°C). The spray of water is to be started and continued for at least 1 hour, maintaining the room temperature at 33 - 37 °F (0.6 - 2.8°C). The room temperature is then to be lowered to 20 - 27 °F (minus 6.7-minus 2.8°C) while continuing the water spray. The rate of change in the room temperature is not critical. The water spray is to be controlled to cause ice to build up on the rod at a rate of approximately 1/4 inch (6.4 mm) per hour and is to be continued until 3/4 inch (19 mm) of ice has formed on the top surface of the rod. The spray is then to be discontinued, but the room temperature is to be maintained at 20 - 27 °F for 3 hours so that all parts of the ENCLOSURE and the ice coating have reached the same temperature.

While ice laden a Type 3S ENCLOSURE and its external mechanisms shall be operable manually or as intended by one person. There shall be no damage to the ENCLOSURE, the enclosed EQUIPMENT, or the mechanism.

If an auxiliary mechanism is provided to break the ice, it is to be used in the test. A separate test is required for each maintained position of each external OPERATOR. If necessary, a hand tool is to be used to remove ice to gain access to the interior of the ENCLOSURE. The use of the hand tool shall not result in functional damage to the ENCLOSURE or the mechanisms.

At the conclusion of the procedure, on a UL Type 3, 3R, 4, 4X, or Type 6 ENCLOSURE, the ice is to be allowed to melt. The ENCLOSURE and its external mechanisms shall not be damaged.

13.8 OIL TEST

The dry ENCLOSURE is to be subjected to a stream of liquid consisting of water and a wetting agent at a concentration of 0.1 % by volume. The liquid is to flow through a nozzle having a 3/8 inch (9.5 mm) inside diameter opening that delivers at least 2 gallons (7.6 L) of the mixture per minute. The stream is to be directed at the ENCLOSURE from all angles from a distance of 12 - 18 inches (300 - 460 mm) for 30 minutes. If the ENCLOSURE houses an externally operated device, the device is to be operated at a rate of approximately 30 operations per minute for the duration of the test. A CONDUIT may be installed to equalize internal and external pressures, but is not to serve as a drain.

At the conclusion of the procedure a UL Type 13 ENCLOSURE shall have no liquid inside.

An ENCLOSURE complying with these requirements is also considered to comply with the Drip Test (subhead 2.13.4), and the Dust Test (subhead 2.13.5).

13.9 METALLIC COATING THICKNESS DETERMINATION

The method of determining the thickness of a zinc coating is described below:

a. The solution to be used for this test is to be made from distilled water and is to contain 200 grams per liter of reagent grade chromic acid $HCrO_3$; and 50 grams per liter of reagent grade concentrated sulfuric acid H_2SO_4. The latter is equivalent to 27 milliliters per liter of reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 % of H_2SO_4.

b. The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of approximately 0.025 inch (0.64 mm) and a length of 5.5 inches (140 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are about 0.025 milliliters each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ± 5 drops per minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

c. The sample and the test solution are to be kept in the test room long enough to stabilize at room temperature. The room temperature is to be recorded. The test is to be conducted at an ambient temperature of 21.1 - 32.2 °C (70 - 90 °F).

d. Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of solvents. Samples are then to be rinsed in water and dried. Care is to be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

e. The sample to be tested is to be supported 0.7 - 1 inch (18 - 25 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested is to be inclined about 45 degrees from horizontal.

f. The stopcock is to be opened and the time in seconds is to be measured until the dropping solution dissolves the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by the change in color at that point.

g. Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface and at an equal number of points on the outside surface at places where the metallic coating may be expected to be the thinnest. On ENCLOSURES made from precoated sheets, the external corners that are subjected to the greatest deformation are likely to have thin coatings.

h. To calculate the thickness of the coating being tested, the thickness factor from Table 7, applicable for the temperature at which the test was conducted, is to be multiplied by the time in seconds required to expose base metal as noted in item (f).

Table 7: Thickness Factors

Thickness Factors, 0.00001 Inches (0.0003 mm) Per Second		
Temperature, °F (°C)	Zinc Platings	
70	(21.1)	0.980
71	(21.7)	0.990
72	(22.2)	1.000
73	(22.8)	1.010
74	(23.3)	1.015
75	(23.9)	1.025
76	(24.4)	1.033
77	(25.0)	1.042
78	(25.6)	1.050
79	(26.1)	1.060
80	(26.7)	1.070
81	(27.2)	1.080
82	(27.8)	1.085
83	(28.3)	1.095
84	(28.9)	1.100
85	(29.4)	1.110
86	(30.0)	1.120
87	(30.6)	1.130
88	(31.1)	1.141
89	(31.7)	1.150
90	(32.2)	1.160

13.10 RAIN TEST

A complete ENCLOSURE with CONDUIT connected - without pipe thread compound - is to be mounted as intended. The tightening torque for rigid CONDUIT threaded into an opening in the ENCLOSURE is to be 800 pound-inches (90 N·m) for 3/4-inch and smaller trade sizes, 1000 pound-inches (113 N·m) for 1-, 1-1/4-, and 1-1/2-inch trade sizes, and 1600 pound-inches (180 N·m) for 2-inch and larger trade sizes. A water spray is then to be applied to the ENCLOSURE from the top and sides for 1 hour.

The water spray apparatus is to consist of three spray heads mounted in a pipe rack as illustrated in Figure 2. Spray heads are to be constructed in accordance with the details shown in Figure 3. The water pressure for all tests is to be maintained at 5 psi (34 kPa) at each spray head. The distance between the center nozzle and the EQUIPMENT is to be approximately 5 feet (1.5 m). The spray is to be directed at an angle of 45 degrees from vertical toward the louvers or other openings nearest current-carrying parts.

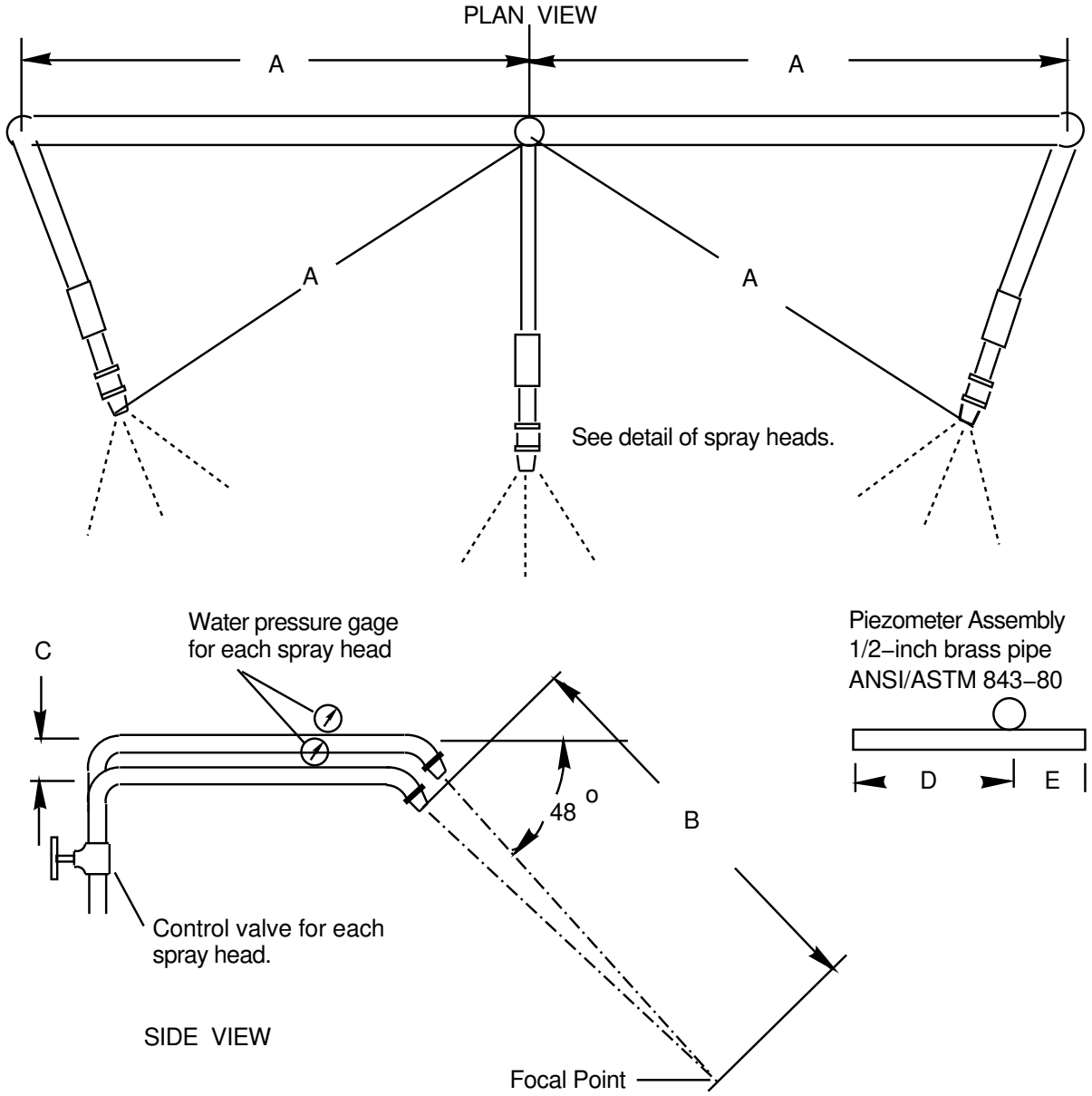
At the conclusion of the procedure:

a. A UL Type 3R ENCLOSURE shall have:

   1. No water visible on insulation or on any electrical COMPONENT or mechanism of the EQUIPMENT, and;
   2. No significant accumulation of water retained by the EQUIPMENT.

b. A UL Type 3 or 3S Enclosure shall have no water inside the ENCLOSURE.

Figure 2: Spray Head Pipe Rack



DIMENSION	INCH	MM
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

Figure 3: Spray Head

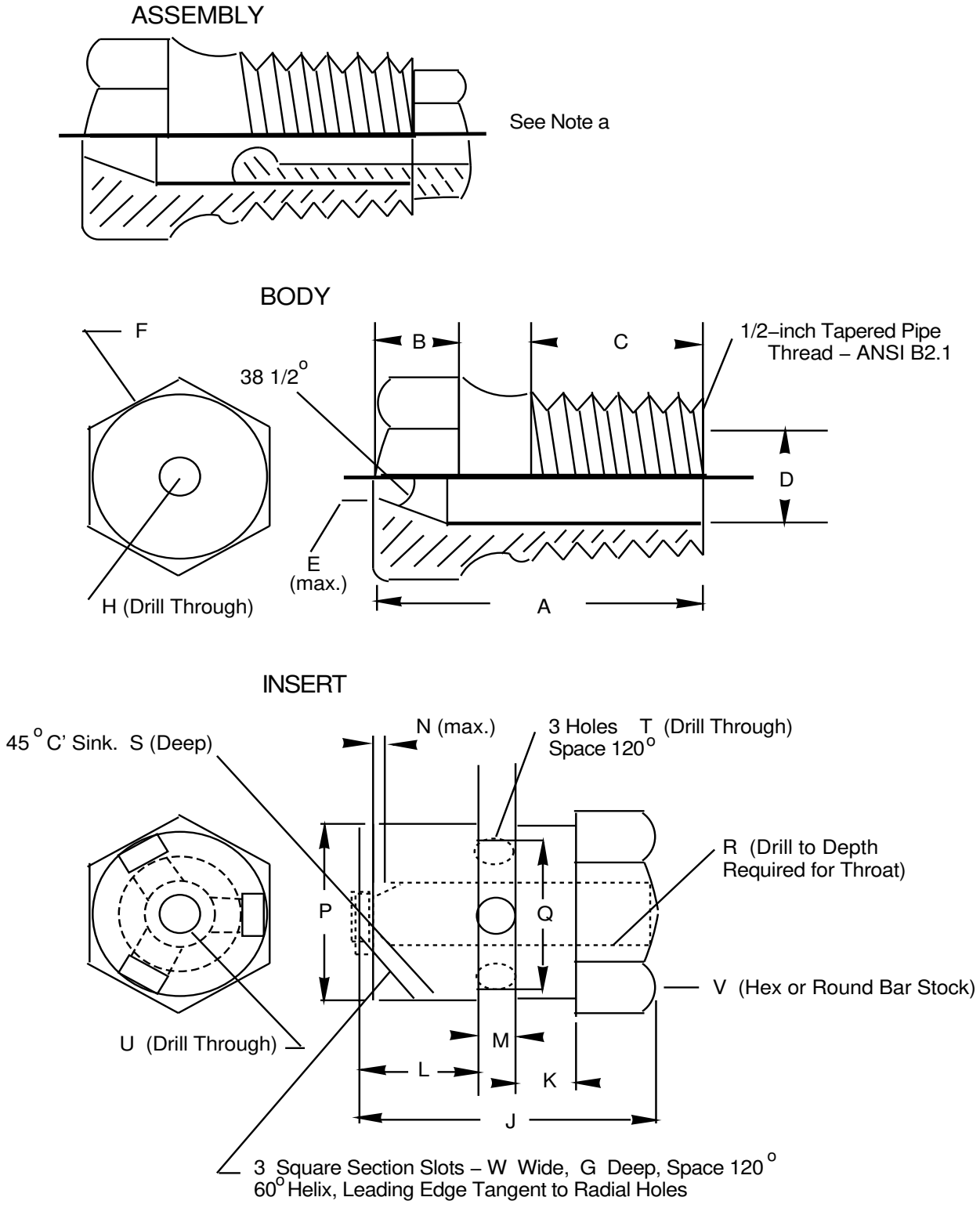


Table 8: Key To Spray Head Dimensions Shown in Figure 3[a]

Dimension	Inch	mm	Dimension	Inch	mm
A	1-7/32	31.0	M	3/32	2.38
B	7/16	11.0	N	1/32	0.80
C	9/16	14.0	P	.575	14.61
D	.578	14.68		.576	14.63
	.580	14.68	Q	.453	11.51
E	1/64	0.40		.454	11.53
F	[c]	[c]	R	1/4	6.35
G	.06	1.52	S	1/32	0.80
H	(No. 9)[b]		T	(No. 35)[b]	2.79
J	23/32	18.3	U	(No. 40)[b]	2.49
K	5/32	3.97	V	5/8	16.0
L	1/4	6.35	W	0.06	1.52

[c]Optional - To serve as wrench grip.

13.11 RUST RESISTANCE TEST

The ENCLOSURE or representative parts of the ENCLOSURE are to be subjected to a salt spray (fog) using the test method in Salt Spray (Fog) Testing, ASTM B117 - 1973, and employing a 5 % by weight salt solution for 24 hours. At the end of the test, the specimens are to be removed from the chamber, are to be washed in clean running water not warmer than 100 °F (37.8°C) to remove salt deposits from the surface, and are to be dried immediately. Corrosion products may be removed by light brushing if required to observe corrosion of the underlying surface.

At the conclusion of the procedure a UL Type 1, 2, 12, or Type 13 ENCLOSURE shall have no visible rust.

Exception: Rust is acceptable in locations where protection is impractical, such as a sliding surface of a hinge, a shaft, or the like.

13.12 SUBMERSION TEST

An ENCLOSURE complying with the requirements in this section is also considered to comply with the Dust Test (subhead 2.13.5), and the Hosedown Test (subhead 2.13.6).

The complete dry ENCLOSURE is to be mounted in a tank with CONDUIT connected, using a pipe-thread sealing compound. The CONDUIT is to be tightened with the torque specified under subhead 2.13.10. The tank is to be filled with water so that the highest point on the ENCLOSURE is 6 feet (1.8 m) below the surface of the water. The ENCLOSURE need not be submersed to a depth of 6 feet (1.8 m) if an equivalent pressure differential between the interior and the exterior of the ENCLOSURE is maintained. This differential may be achieved either by reducing the air pressure inside the ENCLOSURE or by pressurizing the water surrounding the ENCLOSURE. After 30 minutes, the

ENCLOSURE is to be removed from the tank, the excess water is to be removed from the exterior surfaces of the ENCLOSURE, and the ENCLOSURE is to be opened.

At the conclusion of the procedure, a UL Type 6 ENCLOSURE shall have no water inside.

13.13 COMPRESSION TEST

An ENCLOSURE that is thinner than that specified in Tables 1 and 2, in accordance with the exception in DEC STD 080-1 under subhead 1.1.3 Sheet Metal, item (a) shall be reinforced so that its deflection is not more than that of a reference sheet metal ENCLOSURE of the maximum length and width constructed of the minimum required sheet metal thickness.

The ENCLOSURE is to rest on a flat, unyielding horizontal surface. A vertical force is to be applied at any point on the surfaces of the ENCLOSURE except for the door or cover using a flat face of a steel bar having a 1/2 inch (13 mm) square cross section. Force is to be applied to the end, side, and rear walls of each ENCLOSURE. The value of force and limit of deflection are not specified, but the force on each wall of both the test and reference ENCLOSURES is to be sufficient to result in a measurable deflection on the test ENCLOSURE.

13.14 DEFLECTION TEST

A drawn, embossed, flanged, or similarly strengthened door, front, or cover made of metal having a thickness less than specified in DEC STD 080-1 Tables 1 and 2 shall not deflect inward more than 1/4 inch (6.4 mm) when a vertical force of 100 pounds (445 N) is applied at any point on the door, front, or cover.

The test is to be conducted with the door closed and the front or cover mounted and secured on the box in the intended manner. The ENCLOSURE is placed with its back on a flat, unyielding horizontal surface.

The force is to be applied through a bar having a flat, square face 1/2 inch (13 mm) on an edge.

If a flange on the edges of a telescoping door or cover is reduced in width from the value specified in DEC STD 080-1 under subhead 1.1.5 Doors and Covers or is omitted, the door or cover shall not deflect more than 3/8 inch (9.5 mm) when subjected to a force of 100 pounds (445 N) applied at any point 1 inch (25.4 mm) from the edges.

13.15 GASKET TESTS

The requirements in this section apply to a gasket that is required for an electrical ENCLOSURE to maintain a tight fit or to comply with the ENCLOSURE performance requirements.

Foamed or solid neoprene, or rubber compounds, or solid polyvinyl-chloride materials, except foamed materials, shall have physical properties as indicated in Table 9 before and after the conditioning indicated in Table 10.

Table 9: Physical Properties for Gaskets

	Neoprene or Rubber Compounds		Polyvinyl-Chloride Materials	
Physical (a) Property	Before Conditioning	After Conditioning	Before Conditioning	After Conditioning
Tensile Set - Maximum Set when 1 inch (25.4 mm) gage marks are stretched to 2 1/2 inches (63.5 mm), held for 2 minutes and measured 2 minutes after release.	1/4 in (6.4 mm)	-	Not specified	
Elongation - minimum increase in distance between 1 inch (25.4 mm) gage marks at break	250% (3 1/2 in) (88.9 mm)	65% of original	250% (3 1/2 in) (88.9 mm)	75% of original
Tensile Strength - Minimum force at breaking point.	850 psi (586 MPa)	75% of original	1200 psi (8.27 MPa)	90%

a. To be determined using the test methods and apparatus described in Standard Test Methods for Rubber Properties in Tension, ASTM D412-80, except the method for tensile set is to be as specified in this table.

Table 10: Gasket Conditioning

Minimum Gasket Temperature Rise (a) Degrees		Conditioning	
C	(F)	Rubber or Neoprene	Thermoplastic
35	(63)	4 days at 70°C (158°F)in an oxygen bomb at 300 psig (2.068 MPa)	7 days in an air-circulated oven at 87°C (189 °F)
50	(90)	7 days at 80°C (176°F) in an oxygen bomb at 300 psig (2.068 MPa)	10 days in an air-circulated oven at 100°C (212°F)
55	(99)	7 days in an air-circulated oven at 113°C (235.4°F)	
65	(117)	10 days in an air-circulated oven at 121°C (249.8 °F)	7 days at 121°C (249.8°F) or 60 days at 97°C (206°F) in an air-circulated oven
80	(144)	7 days in an air-circulated oven at 136°C (276.8°F)	

(a) Measured during the temperature test

Foamed neoprene or rubber compounds shall not harden or otherwise deteriorate to a degree that affects their sealing properties after conditioning as specified in Table 10.

A thermoplastic gasket shall not deform or melt, or otherwise deteriorate to a degree that will affect its sealing properties after the conditioning as specified in Table 10.

Gaskets of materials other than those specified shall be nonabsorptive and shall provide equivalent resistance to property changes.

A gasket material used in a UL Type 12, 12K, or 13 ENCLOSURE shall not swell more than 25 % or shrink more than 1 % as a result of immersion in No. 3 swelling oil conforming with the specifications of ANSI/ASTM D471-79 for 70 hours at room temperature.

13.16 POLYMERIC ENCLOSURE CONDUIT CONNECTION TESTS

A polymeric ENCLOSURE intended for connection to a rigid CONDUIT system shall not pull apart or sustain damage such as cracking and breaking as a result of the pullout, torque, and bending procedures. If knockouts are incorporated in the ENCLOSURE, they shall remain in place as a result of the procedure described in subhead 2.13.16.4 Knockouts.

Exception: The torque test need not be conducted on an ENCLOSURE that is not provided with a preassembly hub and that complies as follows:

A polymeric ENCLOSURE that (1) is intended for connection to a rigid CONDUIT system, (2) has not been subjected to the torque test and (3) is not provided with a preassembled hub shall have instructions stating that the hub is to be connected to the CONDUIT before the hub is connected to the ENCLOSURE.

13.16.1 Pullout

The ENCLOSURE is to be suspended by a length of rigid CONDUIT installed in one wall of the ENCLOSURE or mounted as intended in service and a pulling force of 200 pounds (890 N) is to be applied for 5 minutes to a length of CONDUIT installed in the opposite wall.

13.16.2 Torque

The ENCLOSURE is to be securely mounted as intended in service. A torque in accordance with subhead 2.13.10 Rain Test is to be applied to a length of installed CONDUIT in a direction tending to tighten the connection. The lever arm is to be measured from the center of the CONDUIT.

Exception: An end-of-line ENCLOSURE - an ENCLOSURE that is intended to be connected at the end of a run of CONDUIT and has only one 3/4 inch maximum trade size opening for the connection of CONDUIT - need only be subjected to a tightening torque of 200 pound-inches (22.6 N·m).

13.16.3 Bending

A length of CONDUIT at least 1 foot (305 mm) long of the intended size is to be installed (1) in the center of the largest unreinforced surface, or (2) in a hub or an opening if provided as part of the ENCLOSURE. the ENCLOSURE is to be securely mounted as intended in service, but positioned so that the installed CONDUIT extends in a horizontal plane. A weight is to be suspended from the end of the CONDUIT to produce the bending moment specified in Table 11. The magnitude of the weight is to be determined from the equation:

$$W = (M - 0.5CL)/L$$

in which:

a. W is the weight, in pounds, to be hung at the end of the conduit.

b. L is the length of the conduit, in inches, from the wall of the enclosure to the point at which the weight is suspended.

c. C is the weight of the conduit, in pounds.

d. M is the bending moment required, in pound-inches.

For the SI system of units, the equation is

$$W = (0.102M - 0.5CL)/L$$

in which:

a. W and C are measured in kilograms.

b. M is in newton-meters.

c. L is in meters.

Table 11: Bending Moment

		Bending Moment - Pound-inches (b)(c) (N·m)	
Normal Mounting Plane of Enclosure Surface (a)	Conduit Size, Inches	Metallic Conduit	Nonmetallic Conduit
Horizontal	All	300 (33.9)	300 (33.9)
Vertical	1/2-3/4	300 (33.9)	300 (33.9)
	1-up	600 (67.8)	300 (33.9)

13.16.4 Knockouts

A knockout is to be subjected to a force of 20 pounds (89 N) applied at right angles by means of a mandrel with a 1/4-inch (6.4 mm) diameter flat end. The mandrel is to be applied at the point most likely to cause movement of the knockout.

13.17 SECUREMENT OF SNAP-ON COVER TEST

The tests described below are to be conducted in the as-received condition and after the cover has been removed and replaced 10 times.

A snap-on cover providing part of the overall ENCLOSURE that gives access to uninsulated LIVE PARTS and does not have a separate tool-operated fastener shall have no apparent means for removal such as an extending tab, and is to comply with the following:

a. A cover that could be disengaged from the ENCLOSURE by a squeezing force applied with one hand shall not be released when a squeezing force of 14 pounds (62 N) or less is applied at any two locations not more than 5 inches (127 mm) apart. The distance is to be measured by a tape stretched tightly over that portion of the surface of the cover that would be encompassed by the palm of the hand.

b. A cover shall not disengage from the ENCLOSURE when a direct pull force of 14 pounds is applied by gripping the cover at any two convenient locations, and

c. A cover shall not be disengaged from the ENCLOSURE by an impact of 1 foot-pound (1.4 J) applied to the accessible faces of the cover - one blow per face. The impact is to be applied by a steel ball having a diameter of not less than 2 inches (51 mm).

13.18 ROD TEST

Openings in ENCLOSURES housing LIVE PARTS shall be of such size or shape as to prevent the passage of a straight rod having a diameter of 0.500 inches (12.7 mm) except that, if the distance between bare LIVE PARTS and the ENCLOSURE is greater than 4 inches (100 mm), openings may be such as not to permit the passage of a similar rod 0.750 inches (19.1 mm) in diameter.

13.19 MECHANICAL TESTS FOR CSA

The sequence of these mechanical tests may be altered or waived at the discretion of CSA.

a. A knockout in CSA ENCLOSURE 5 shall remain in place when subjected to a steadily applied load of 20 pounds (89 N) applied for 1 minute normal to the face of the plate by means of a mandrel with a 1/4 inch (6.4 mm) diameter flat end. The mandrel shall be applied at the point most liable to cause movement of the knockout.

b. Threaded CONDUIT openings shall be capable of withstanding the following tests, applied to a short length of CONDUIT threaded into the opening, at the values specified in Table 12.

   1. Bending moment in any direction; and
   2. Torque in the direction to tighten the CONDUIT.

Table 12: Bending Moment and Tightening Torques

Conduit Size (inches)	Pound Inches
1/2	300
3/4	500
1	700
1 1/4	1,000
1 1/2	1,200
2 and larger	1,600

c. ENCLOSURES designed for or equipped with detachable threaded hubs which are held in a circular opening, such as a knockout opening, by means of a CONDUIT locknut or equivalent shall not be required to meet the requirements of item (b), but shall withstand a misalignment test applied to any detachable hub installed in the ENCLOSURE, as follows:

   A 10 foot (3.05 m) length of 3 inch (75 mm) trade size steel CONDUIT shall be tightly threaded into a detachable threaded CONDUIT hub; and the hub shall be installed in one or more CONDUIT locations in the ENCLOSURE to be tested. A CONDUIT of smaller size shall be used if the maximum size the ENCLOSURE is designed to accept is less than 3 inches (75 mm); and the approval listing shall record this smaller (maximum) size. The opposite end of the CONDUIT from the ENCLOSURE shall be displaced from its axis in all directions a distance of 3 inches, except the displacement

shall be reduced if necessary to avoid exceeding the bending moment required in Table 12.

d. The effectiveness of the ENCLOSURE shall not be impaired, there shall be no serious permanent distortion of the ENCLOSURE, and the ENCLOSURE must meet the applicable water test before, during, and after the tests specified in items (b) and (c).

e. ENCLOSURES may be subjected to vibration tests to determine their security of assembly.

14 OVERVOLTAGE AND UNDERVOLTAGE TEST

a. If EQUIPMENT, such as a combination motor controller, is provided with a control-circuit transformer, the voltage for conducting the undervoltage test is to be applied on the primary side of the transformer at 90 percent of the rated transformer primary voltage.

b. The electromagnet is first to be energized under the conditions of the temperature test until constant coil temperatures are observed. The control-circuit voltage is then to be reduced to the undervoltage test voltage explained in item (a). The CONTROL CIRCUIT is then to be opened and closed several times to determine if full closure of the armature results.

c. The CONTROL CIRCUIT voltage is to be increased to the overvoltage test value until constant temperatures are observed using the thermocouple method. The voltage is then to be rapidly reduced to the temperature test voltage and the CONTROL CIRCUIT is to be immediately opened and closed several times to determine if full closure of the armature results.

d. An electromagnet intended for intermittent duty is to be tested to determine whether it complies with the requirements of this heading for the time rating specified. If resistance is inserted into the electromagnetic circuit after closing of the contactor, this resistance is to be included in the circuit when the coil is energized under temperature test conditions.

An electromagnet shall withstand 110 % of the RATED VOLTAGE without apparent damage to the operating coil and shall operate at 80 % of its RATED VOLTAGE if for use on direct current or 85 % of its RATED VOLTAGE if for use on alternating current.

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